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THE PRE-CAMBRIAN OF WESTERN PATRICIA[1]

E. M. BURWASH
University of Manitoba, Winnipeg, Canada

The purpose of this paper is briefly to summarize the results of two seasons' field work in western Patricia. Patricia lies in the extreme northwestern part of the province of Ontario, north of the Winnipeg, English, and Albany rivers, and their expansions, Lac Seul and Lake St. Joseph. The areas studied by the writer lie in the southwestern part of the district, and in a sense intervene between the classic areas studied by Lawson and others around the Lake of the Woods and Rainy Lake and a number of areas in the province of Manitoba, more recently studied by Bruce, Alcock, Moore, and others. Reconnaisance work had already been done in the Lac Seul region and northward along the Trout Lake, Wennasaga, Cat Lake, and other rivers by Dowling, A. W. G. Wilson, Camsell, and others, and the work of E. S. Moore in the region southeast of Lake Winnipeg had extended in a few places across the boundary of Manitoba into Patricia. The writer's work was done under the direction of the Department of Mines of Ontario in the Lac Seul region in 1919 and along the Ontario-Manitoba boundary from the Winnipeg River northward in 1921. No great originality or finality is claimed for the results as the work in both cases was confined to narrow strips of country immediately adjacent to the survey-lines or rivers which were traversed, and was not of such a nature as to allow of much areal mapping, which would afford a more complete knowledge of the relationships of the various formations than is possible by reconnaisance methods. There has not been time for microscopic study of the rocks in the boundary region, but their general character is evident and in most cases they have been determined already with accuracy by Moore, so that data are now available for at least a tentative discussion of the relations of the two areas with one another and with the surrounding regions.

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[1] Read at the Toronto meeting of the American Association for the Advancement of Science.

Lawson's general statement of the geological sequence of the Lake Superior region is as follows:

Algonkian	Keweenawan	
	Unconformity	
	Animikie	
Eparchaean Interval		
Archean	Algoman granites, gneisses, etc.	
	Irruptive contact	
	Upper Huronian	
	Unconformity	
	Lower Huronian	
	Unconformity	
	Laurentian granites, gneisses, etc.	
	Irruptive contact	
	Keewatin	Ontarian
	Coutchiching	

The Algonkian formations need not concern us for the purposes of this paper, although dikes exist in some of the areas considered which may be of Keweenawan age.

The region around Lac Seul and northward as interpreted by the writer from data collected in 1919 includes the following geological sequence:[1]

4. Younger porphyritic granite (Birch Lake River).

3. Older red and gray, sometimes gneissoid granites.

2. Upper sedimentary and schist series, including a (basal?) conglomerate, hornblende schist and other schists and possibly limestones and quartzites.[2]

Lower volcanic and schist series, including more or less altered volcanic rocks of rhyolitic, andesitic, and basaltic types, frequently ellipsoidal in structure, hornblende schists, in part ferruginous, and some jaspylite.

1. The lowest member of this succession is correlated with some confidence with the Keewatin of Lawson on account of its litho-

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[1] But see the *Report of the Department of Mines of Ontario*, Vol. XXIX, Part 1 (1920), p. 181, for an alternative classification.

[2] The two last were not seen by the writer. See C. B. Dowling, *Geol. Surv. Can.*, Vol. VII, Part F.

logical resemblance, and because it is the oldest rock-formation present and antedates all of the granites with which it is in contact. Tentatively, however, the local name "Lac Seul Series" may be applied to it.

2. The series above the volcanics appears to be of predominantly sedimentary origin, with a basal conglomerate which has a rather wide extent. It was observed especially at Slate and Birch lakes and was also reported by Dowling at Red Lake. In all three localities it is of practically identical lithological composition. Following Moore's example in the case of a similarly related series in eastern Manitoba, it was assigned to the Lower Huronian.[1]

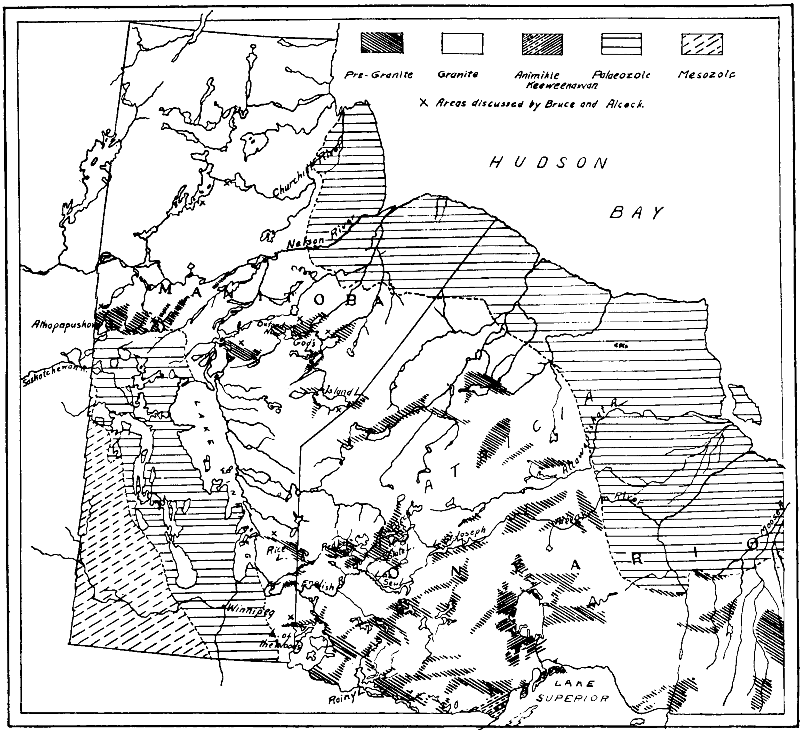

FIG. 1.—Map indicating pre-Cambrian areas mentioned in this paper

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[1] See *Ont. Dept. Mines Report,* 1920, p. 181, and compare *Geol. Surv. Can. Summary Report,* 1912, pp. 262 ff.

However, it affords no evidence of this so far as examined either by lying unconformably on post-Keewatin granites or by the presence of granite pebbles in the conglomerate. Therefore, its assignment to the Lower Huronian would imply either (1) that the granites of this region are all of post-Lower Huronian age, or (2) that the denudation of the great erosion interval which followed, or accompanied and followed, the intrusion of the Laurentian batholiths, was not here enough to uncover the batholiths before the Lower Huronian sedimentation began. If batholithic intrusion took place here in Laurentian time, the batholiths were not uncovered until much later perhaps between the Upper and Lower Huronian or even during the Eparachaean interval. Of these two alternatives, the second appears to the writer to be the less probable, judging by comparison with other regions not far distant. Neither alternative would demand the complete absence of Laurentian granite pebbles, since these might have been transported from a distance, and the quartz pebbles, which occur and which are well rounded in contrast to the angular chert-pebbles of Keewatin origin, probably are the residuals of such traveled material. For this series the name of "Birch Lake Series" is suggested.

3. The granite bodies which were observed in intrusive relations with the Lac Seul (Keewatin) series only are in two cases pink to grayish pink in color. In some parts, usually near contacts or where inclusions of older rocks are abundant, they display a gneissoid texture; in the central parts of the exposed areas and where relatively free from inclusions they are more massive. They are also in parts porphyritic. The rocks with which they are found in intrusive contact are frequently cut by dikes of pegmatite, while aplitic dikes as well as pegmatite occur within the mass of the granite itself. The rock is biotite granite with some hornblende, micropegmatite, and microcline, but no muscovite, tourmaline, or titanite. Another type of granite observed in intrusive contact with both the lower (Lac Seul or Keewatin) and upper (Birch Lake) schist series, is of gray color and is practically a binary granite with microcline as the chief feldspar. It also contains a little tourmaline, some oligoclase or andesine, and a little zircon and garnet. In the pegmatite dikes which accompany this granite tourmaline and

muscovite are largely developed. This type of granite occurs on the Wennasaga River from a point about ten miles above Slate Lake to Hailstone Lake, and also on Pakwash and Little Shallow lakes, where it has a syenitic phase with very little quartz. The same intrusion may be represented by dikes on a small island near the outlet of Lac Seul, which are composed of mica diorite.

Granites and gneisses of the red type were observed to the south of South Cove, Lac Seul, on the lower Wennasaga River, in the Cat River basin from Big Portage Lake to Springpole Lake, and on the lower Woman and Trout Lake rivers.

The relations in age between these two types of granite were not observable on the route followed by the writer. Both are post-Keewatin. The gray type is later also than the upper schist series, and both may be. If one is Laurentian and the other later, say Algoman, the Algoman is the gray granite.

There is, in addition, a coarsely porphyritic red granite intrusive in the red granite-gneiss of the Birch Lake River. It was not seen in contact with the schists, either upper or lower. This porphyritic granite is distinguished from the others by the presence of accessory titanite.

We pass now to the area studied during the summer of 1921 which lies along the Ontario-Manitoba boundary, a north and south meridian line, and is on the average about seventy-five miles (from sixty to one hundred) west of the field already described. Here we find as the oldest constitutents of the complex two series of rocks quite similar lithologically, and in their stratigraphic relation to each other, to the two series of schists already described.

1. The lower is a predominantly volcanic series which includes[1] greenstone (massive diabase and ellipsoidal lavas), quartz-porphyry, rhyolite, trachyte-felsite, green and gray schists due to alteration of these, and in one place a bed of white quartzite, partly iron-stained which occurs on the south side of the Winnipeg River a little west of the boundary, and has a total thickness of about thirty feet. To these rocks the name "Rice Lake Series" was given by Moore.

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[1] E. S. Moore, *Geol. Surv. Can. Summary Report*, 1912, pp. 262 ff.

2. Lying above this is a predominantly sedimentary series whose most important rock is an extensive and thick conglomerate composed of the materials of the lower series with the exception of two constituents, a granite which does not appear within the area examined by Moore, and cherty fragments from iron-formations which were also not found in the lower series, although similar rocks are found in the upper series itself. These cherty fragments may have come from portions of the lower (Rice Lake) series since removed by erosion, or from parts farther east where they are known to occur in the lower series. There is a possibility that a gray gneissoid granite which may be seen on the Winnipeg River intruding the Rice Lake series may account for the granitic pebbles in the conglomerate. This gneissoid granite was not found in intrusive contact with the upper (Wanipigow) series and is older than the red and grayish-yellow or white binary pegmatitic granites which occupy most of the region, since these granites and the pegmatites derived from them intrude the older gray granite, and the red granite contains inclusions of it which, in many observed cases, have themselves included xenoliths of the Rice Lake (Keewatin) series. But while this is conclusive as to the relative ages of the various granites and the volcanic series, it is not conclusive as to the relative ages of the gray granite and the upper or Wanipigow series. The Wanipigow may then be older than any of the local granites and the pebbles found in its conglomerates may have been transported from a distance.

Comparing the Wanipigow conglomerate with that found in the upper or Birch Lake series of the Lac Seul region, it is true of both that they consist largely of pebbles derived from the volcanic rocks which immediately underlie them. Both also contain fragments of chert and jasper, which can be accounted for by the presence of iron-formation in the lower series of the eastern field, but are absent in that of the western area. In both, too, are pebbles of quartz. In the Lac Seul area these are hard to account for. They are well rounded and consist of a "sugary" white quartzite, partly stained to a yellowish color by iron oxide, which shows under the microscope "a granular texture of somewhat interlocking grains, no secondary enlargement of grains, slight amounts of bleached biotite and brown iron oxide, very occasional grains of apatite and magnetite and flecks of kaolin." The quartz pebbles in the conglomerate on the interprovincial boundary are of a rather more glassy and massive appearance and must undoubtedly be described as vein-quartz. They cannot be accounted for as coming from the quartz veins which are now to be seen throughout the area, as these are of later age and owe their origin to the subsequent granite intrusions. But there is a bed of quartzite, as already described in the Rice Lake rocks, which outcrops on the Winnipeg River a little west of the Ontario-Manitoba boundary, and to this the pebbles of the conglomerate may in part be attributed, while others are no doubt derived from distant sources.

Taking everything into account there seem to be fairly good reasons for correlating the conglomerate horizons of the two areas and also the volcanics which underlie them, which may be taken as in all probability Keewatin. The conglomerate would then agree in age with the great erosion interval which has been found elsewhere after the Keewatin. In the region to the south and east, however, the extrusion of the volcanics, partly at least under water, was followed by mountain-building accompanied by granitic intrusion and denudation. In the area which is now under review there is no evidence of angular unconformity between the volcanics and the sedimentaries. The sedimentaries may have been largely subaerial in origin and in that case the history indicated is simply (1) emergence, (2) erosion of low-lying land to a surface of low relief, and (3) deposition of coarse materials perhaps on a piedmont plain. Some of these materials are of local origin while others (the quartzes, the cherts in part, and the granites) have been transported for greater distances.

A recent paper by Drs. Alcock and Bruce[1] sums up very well the results obtained from a study of a number of areas in northern Manitoba together with that studied by Moore to the southeast of Lake Winnipeg and the Star Lake area on the Ontario boundary farther south—in all ten localities. Their general conclusion is that the historical succession begins in most instances, as here, with very ancient volcanic extrusions. This was preceded in some cases by sedimentation, as in the Rainy River region, "in others, sediments were interbedded with the volcanics, and in other areas these early periods of sedimentation continued long after the extrusion of lavas had ceased." In some cases a conglomerate exists which may mark an unconformity between the two divisions of this pre-granite series, as in the Lac Seul area; in others conglomerates occur at several horizons in the upper sediments, but some of them are not of great lateral extent, while graywackes and arkoses indicate little transportation or sorting and possibly subaerial deposition. In some places cross-bedded deposits are interpreted as ancient deltas.

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[1] *Bull. G.S.A.*, Vol. XXXII, pp. 267–92.

The whole would agree with the hypothesis that while post-Keewatin mountain-building occurred in the Rainy Lake field and others farther east, the country to the north and west, although elevated above sea-level, remained in the condition of a piedmont costal plain and, not being folded, was not intruded by granites of Laurentian age.[1] At the same time it was covered with the ill-sorted products of mountain erosion, largely through the action of torrential streams. At a later time, however, this region was subjected to folding, batholithic intrusion, and subsequent deep erosion. This was followed in some localities by one or more periods of deposition with intervening folding and erosion, after which long erosion had produced peneplanation before the advance of the Ordovician sea.

This would agree very well with the facts observed by the writer, except that the later sediments following the first folding (Upper and Lower Missi, Churchill quartzites, etc.), do not occur in the region on which this paper is based.

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[1] An exception to this is made in the case of the Athapapuskow area in northwestern Manitoba which would appear to limit the area in which the Laurentian may be absent on the northwest.